The Consultative Committee for Space Data Systems

Draft Recommendation for
Space Data System Standards

TC SPACE DATA LINK PROTOCOL

DRAFT RECOMMENDED STANDARD

CCSDS 232.0-P-1.1

PINK SHEETS
December 2008

4.1.4.1.3 If present, the Frame Error Control Field shall occur within every Transfer Frame transmitted within the same Physical Channel throughout a Mission Phase.

NOTES

1 The purpose of this field is to provide a capability for detecting errors which may have been introduced into the Transfer Frame during the transmission and data handling process.

2 Whether this field should be used on a particular Physical Channel will be determined based on the mission requirements for data quality and the selected options for the underlying Channel Coding Sublayer.

4.1.4.2 Frame Error Control Field Encoding Procedure

4.1.4.2.1 The Frame Error Control Field is computed by applying Cyclic Redundancy Check (CRC) techniques. The Frame Error Control Field Encoding Procedure shall accept an (n–16)-bit Transfer Frame, excluding the Frame Error Control Field, and generate a systematic binary (n,n–16) block code by appending a 16-bit Frame Error Control Field as the final 16 bits of the codeblock, where n is the length of the Transfer Frame.

NOTE – The Bit Numbering Convention as specified in 1.6.3 is applicable below.

4.1.4.2.2 The equation for the contents of the Frame Error Control Field is:

$$\text{FECF} = [(X^{16} \cdot \text{M}(X)) + (X^{(n-16)} \cdot \text{L}(X))] \text{ modulo } \text{G}(X)$$

$$= P_0 \cdot X^{15} + P_1 \cdot X^{14} + P_2 \cdot X^{13} + \ldots + P_{14} \cdot X^{1} + P_{15} \cdot X^{0}$$

where

all arithmetic is modulo 2;

FECF is the 16-bit Frame Error Control Field with the first bit transferred being the most significant bit P_0 taken as the coefficient of the highest power of X;

n is the number of bits in the encoded message;

M(X) is the (n-16)-bit information message to be encoded expressed as a polynomial with binary coefficients, with the first bit transferred being the most significant bit M_0 taken as the coefficient of the highest power of X;

L(X) is the presetting polynomial given by

$$\text{L}(X) = \sum_{i=0}^{15} X^i ;$$

G(X) is the generating polynomial given by

$$G(X) = X^{16} + X^{12} + X^{5} + 1.$$

~~NOTE — The $X^{(n-16)} \cdot L(X)$ term has the effect of presetting the shift register to all '1' state prior to encoding.~~

NOTES

1 The $X^{(n-16)} \cdot L(X)$ term has the effect of presetting the shift register to all '1' state prior to encoding.

2 A possible FECF generator implementation is shown in figure 4-4. For each frame, the shift register cells are initialized to '1'. The ganged switch is in position 1 while the information bits are being transferred and in position 2 for the sixteen FECF bits.

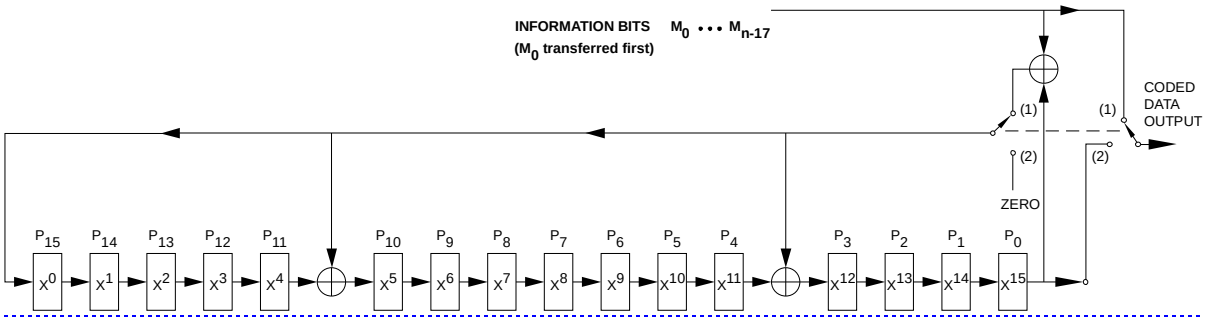

Figure 4-4: Logic Diagram of the Encoder

4.1.4.3 Frame Error Control Field Decoding Procedure

The error detection syndrome, S(X), is given by

$$S(X) = [(X^{16} \cdot C^*(X)) + (X^{n} \cdot L(X))] \text{ modulo } G(X)$$

where

C*(X) is the received block, including the Frame Error Control Field, in polynomial form, with the first bit transferred being the most significant bit C_0* taken as the coefficient of the highest power of X; and

S(X) is the syndrome polynomial which will be zero if no error is detected and non-zero if an error is detected, with the most significant bit S_0 taken as the coefficient of the highest power of X.

The received block C*(X) equals the transmitted codeblock C(X) plus (modulo two) the n-bit error block E(X), C*(X) = C(X) + E(X), where both are expressed as polynomials of the same form, i.e., with the most significant bit C_0 or E_0 taken as the binary coefficient of the highest power of X.

NOTE – A possible syndrome polynomial generator implementation is shown in figure 4-5. For each frame, the shift register cells are initialized to '1'. The frame includes *n*-bits, i.e., (*n*-16) information message bits plus the 16 bits of the FECF. All the *n* bits of the frame are clocked into the input and then the storage stages are examined. For an error-free block, the contents of the shift register cells will be 'zero'. A non-zero content indicates an erroneous block.

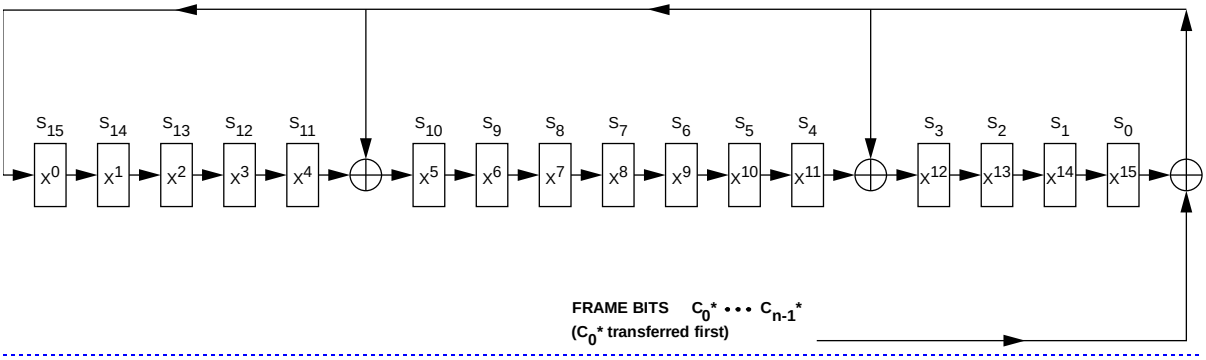

Figure 4-5: Logic Diagram of the Decoder

4.2 PROTOCOL DATA UNIT (CLCW)

4.2.1 COMMUNICATIONS LINK CONTROL WORD

4.2.1.1 General

4.2.1.1.1 The Communications Link Control Word (CLCW), which is the protocol data unit transmitted from the receiving end to the sending end, shall provide the mechanism by which the FARM at the receiving end reports the status of frame acceptance to the Frame Operation Procedure (FOP) at the sending end.

NOTES

1 The controlling specification for how the CLCW is used within the COP is contained in reference [4].

2 CLCWs are usually carried in the Operational Control Field of TM or AOS Transfer Frames (references [B5] and [B6]) using the MC_OCF or VC_OCF Service.

3 The CLCW is the only reporting mechanism for this protocol. Although it is not necessary that the CLCW reporting rate (from the receiving end to the sending end) match the Transfer Frame transfer rate (from the sending end to the receiving end), some minimum CLCW sampling rate is necessary for the proper operation of the COP.

5.4 MANAGED PARAMETERS FOR A MAP CHANNEL

The managed parameters associated with a MAP Channel shall conform to the definitions in table 5-4.

Table 5-4: Managed Parameters for a MAP Channel

Managed Parameter	Allowed Values
Maximum Frame Data Unit Length (octets)	1, 2, …, 1019
Transfer Frame Version Number	1
Spacecraft ID	Integer
VCID	0, 1, …, 63
MAP ID	0, 1, …, 63
Data Field Content	Packets, MAP_SDU
Blocking (if Data Field Content is Packets)	Permitted, Prohibited
Segmentation	Permitted, Prohibited
MPA_SDU Length (octet) (if the MAP permits Segmentation)	Integer

5.5 MANAGED PARAMETERS FOR PACKET TRANSFER

The managed parameters associated with a Virtual or MAP Channel used for the VC or MAP Packet Service shall conform to the definitions in table 5-5.

Table 5-5: Managed Parameters for Packet Transfer

Managed Parameter	Allowed Values
Transfer Frame Version Number	1
Spacecraft ID	Integer
VCID	0, 1, …, 63
MAP ID (for MAP Packet Service)	0, 1, …, 63
Valid PVNs	Set of Integers (see reference [5])
Maximum Packet Length (octets)	Integer
Whether incomplete Packets are required to be delivered to the user at the receiving end	Required, Not required